Upper Savannah Basin Water-Demand Projections

Alex Pellett
Hydrologist
SC Department of Natural Resources
Land, Water and Conservation

Upper Savannah River Basin Council
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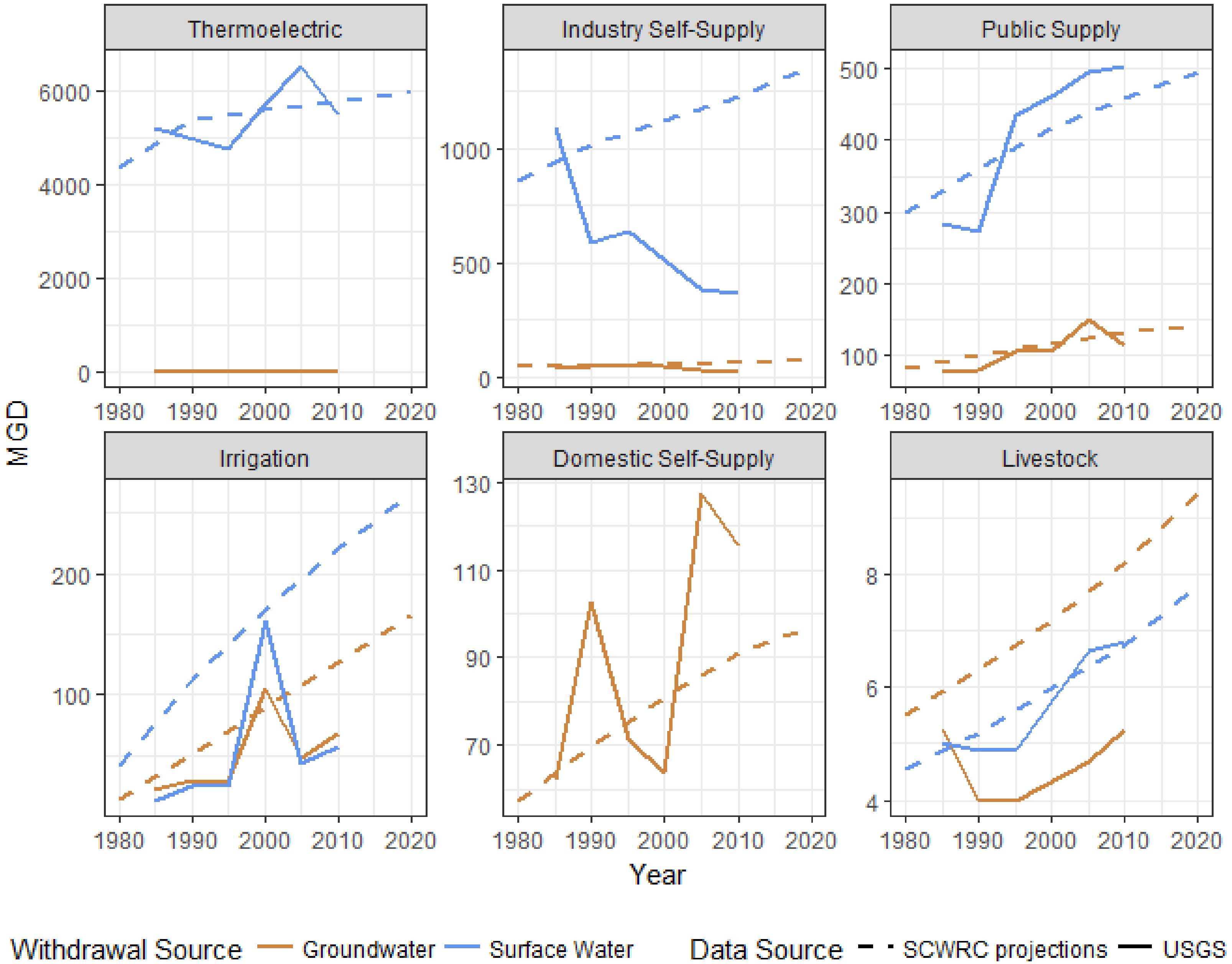
Is It Possible to Predict the Future?



A 1970's edition of water demand projections can be compared with historical water use.

Can we expect to perform any better?

Projections are not forecasts

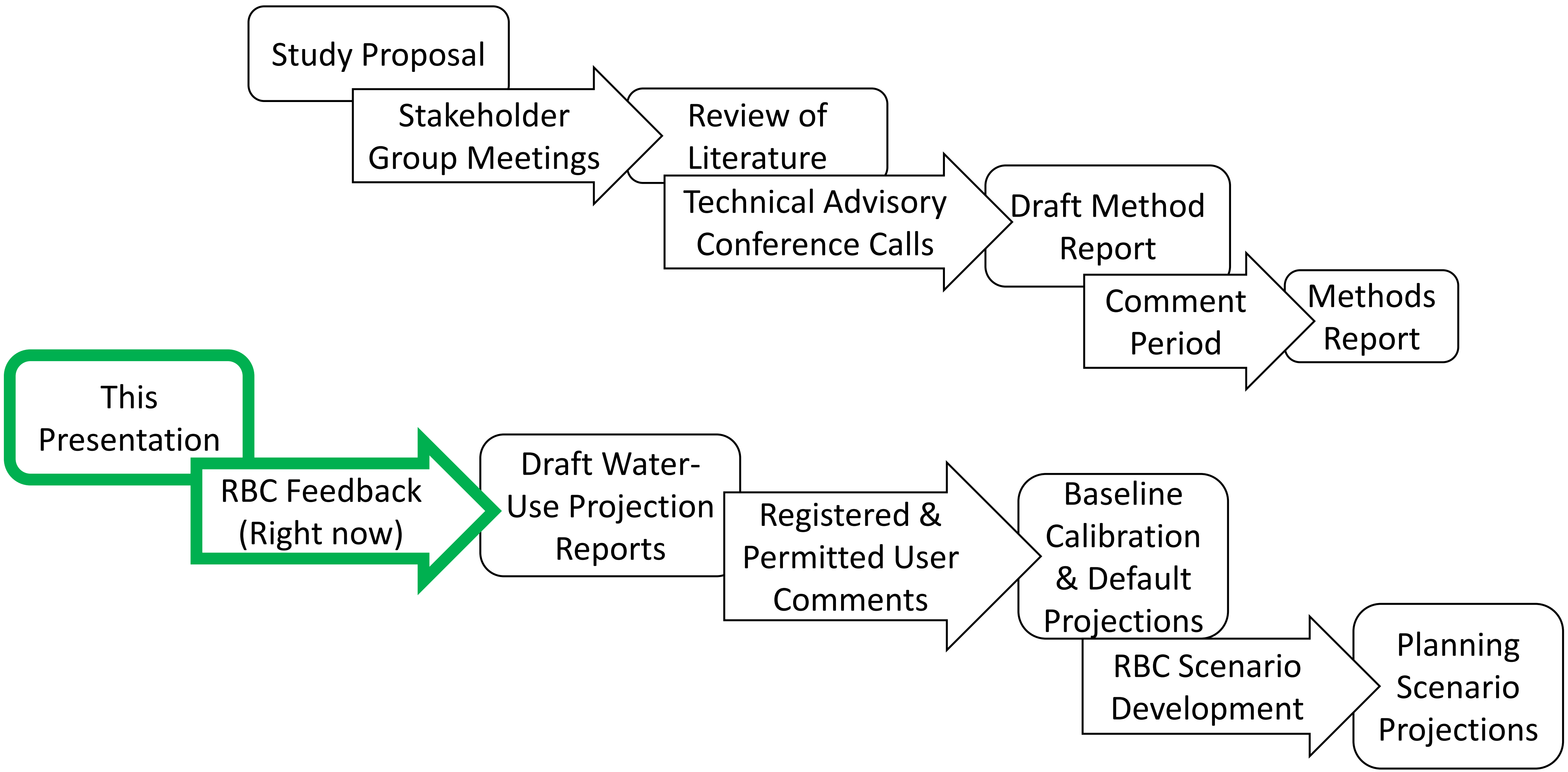
<u>Forecast</u>

- Educated guess.
- Based on expected conditions and actions.
- Timeframe limited by predictability of future conditions.
- Aim to be accurate.

<u>Projection</u>

- Extrapolation of trend.
- Based on hypothetical scenarios.
- Timeframe can extend beyond the limits of effective forecasting.
- Aim to be informative.

Stakeholder Input Throughout the Process



Development of the Methods

2016 -2017 - meetings with stakeholder interest groups for input on water-demand projection methods and data sources.

- SCAWWA Water Utility Council
- SC Water Quality Association
- SC Farm Bureau Water Committee
- Chamber of Commerce Environmental Technical Committee
- SC Water Planning Process Advisory Committee (PPAC)

Stakeholder Feedback

- Water Works Association, Utility Council
  - Use weather and demographic variables for long term forecasts.
  - Consider impacts of outdoor use restrictions.
- Chamber of Commerce, Environmental Committee
  - Provide information on a reach scale for real-world application.
  - Guarantee privacy of survey responses.
- Farm Bureau, Water Committee
  - Agricultural return flows can be significant.
  - Not all cropland can be profitably irrigated.
  - Vegetables and hemp production could increase.
- Water Quality Association
  - Some systems are highly interconnected.
  - Inflow and Infiltration can be significant.

Development of the Methods

2018 - technical advisory conference calls with representation from a variety of fields of experience.

- Public water supply (17)
- Thermo-electric power (5)
- Manufacturing (5)
- Government (22)
- Consultants (4)
- Legal (2)
- Golf (2)
- Agriculture (5)
- Environment (4)
- Research & education (11)

Acknowledgements to Chrissa Waite and Stuart Norvell of USACE and Dr. Jeff Allen and Dr. Tom Walker of the SCWRC for their collaboration on developing the water demand projection methods.

Technical Advisory Committee Feedback

- General recommendations:
  - provide draft projections to local stakeholders.
  - provide an opportunity for feedback.
  - do not rely on overly complex methods.
- Sector specific recommendations:
  - **Thermo-electric**: Contact the utilities directly
  - **Public supply**: Do not rely on complex statistical methods which may underestimate demand.
  - **Industry**: Use economic output, not employment as the driver variable.
  - **Agricultural Irrigation**: A more technical method may be appropriate for projecting irrigated acreage.
  - **Golf**: A simpler projection method was recommended due to the relatively low volume of water use.

Development of the Methods

2018 – Publication of "Water Users' Perspectives: Summary of Withdrawal Survey Responses and Commentary" in *Journal of South Carolina Water Resources.*

2019 – Projection Methods for Off-stream Water Demand in South Carolina published online by SCDNR following reviews by an editorial board, the PPAC, and technical advisory conference call participants.

Pellett, C. Alex (2020) "Mapping Center Pivot Irrigation Fields in South Carolina with Google Earth Engine and the National Agricultural Imagery Program," *Journal of South Carolina Water Resources*: Vol. 7 : Iss. 1 , Article 4. Available at: https://tigerprints.clemson.edu/jscwr/vol7/iss1/4

Pellett, C. Alex (2024) "Review of Agricultural Water Use in South Carolina," *Journal of South Carolina Water Resources* (In Review)

Equations to Define the Terms

Equation 1: Water Demand Mass Balance

$$Demand = Withdrawal + Purchase + Reuse - Sales - Loss - \Delta Storage + Shortage$$

Where:

Demand	:	Off-stream water demand
Withdrawal	:	Total water withdrawal from source water bodies
Purchase	:	Total purchases of water from distributors
Reuse	:	Total reuse of water previously used for another purpose
Sales	:	Total wholesale transfers of water to another user or distributor
Loss	:	Total losses of water preventing it from being put to use
ΔStorage	:	Net change in off-stream storage
Shortage	:	Water not available to meet the objectives of water users

Equation 2: Return Flow Mass Balance

$$Return\ Flow = Discharge - Inflow\ \&\ Infiltration$$

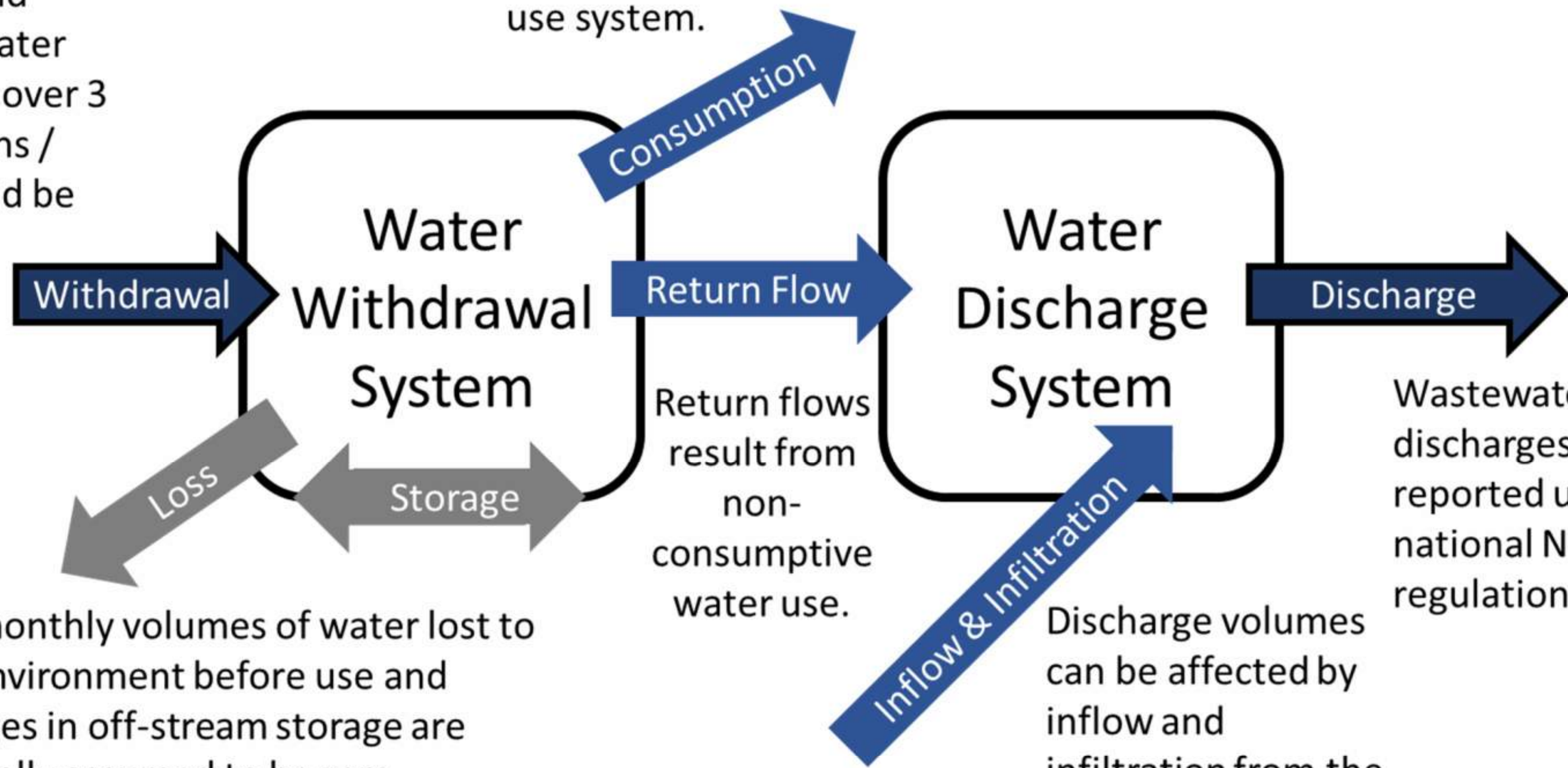
Where:

Return Flow	:	Water returned to the environment after non-consumptive uses
Discharge	:	Concentrated discharges to surface water bodies (NPDES data)
Inflow & Infiltration	:	Waste-water resulting from inflow and infiltration (I/I)

Mass Balance Illustration

Permitted and registered water withdrawals over 3 million gallons / month should be reported to SCDHEC.

Water that is used and evaporates or transpires to the atmosphere is *consumed* from the water use system.



Return flows result from non-consumptive water use.

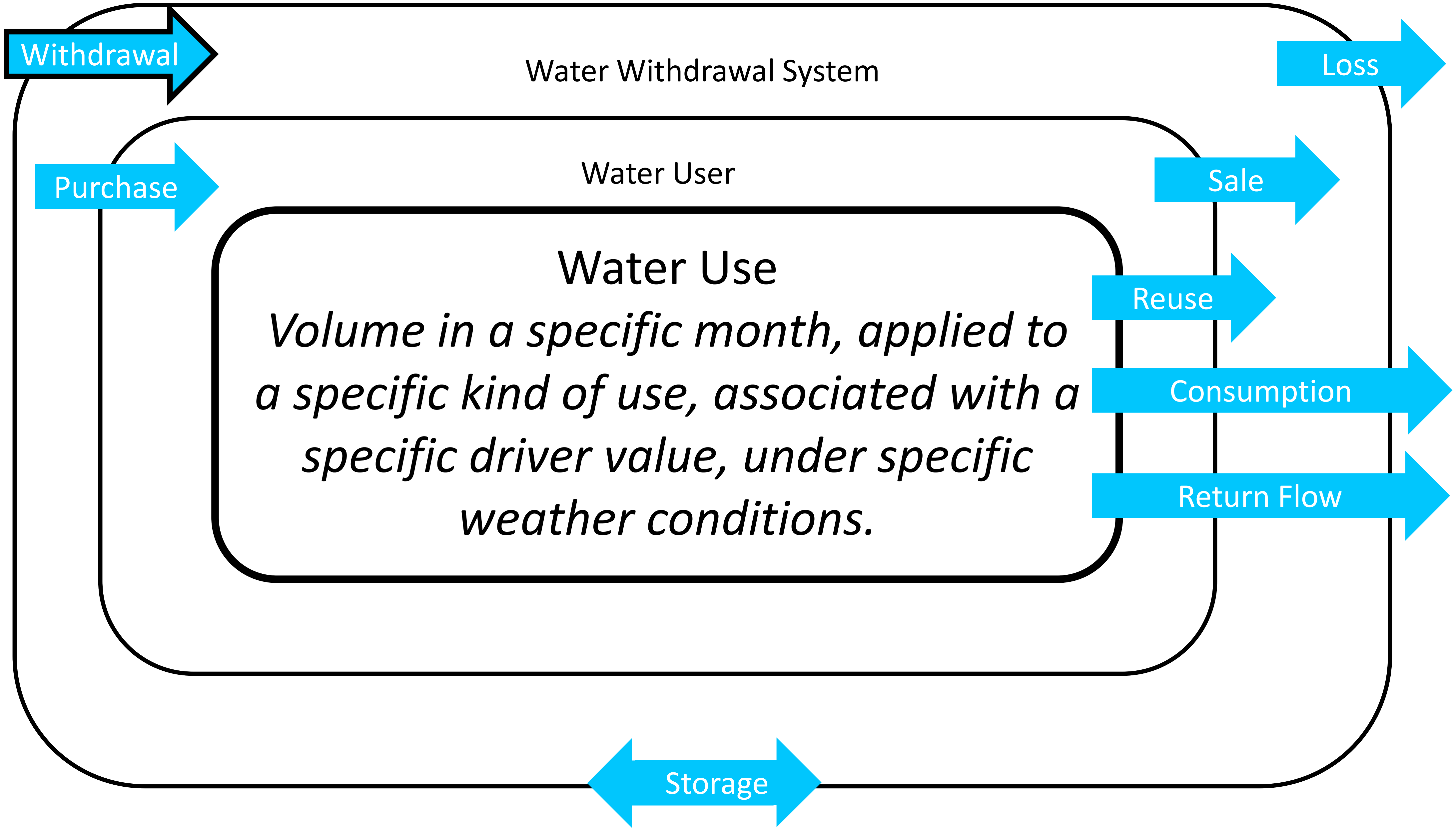
Wastewater discharges are reported under the national NPDES regulations.

The monthly volumes of water lost to the environment before use and changes in off-stream storage are generally assumed to be zero.

Discharge volumes can be affected by inflow and infiltration from the environment.

Consumption, return flow, and inflow & infiltration are estimated over the baseline period to project future non-consumptive use.

A More Detailed Model



Projections

- Water demand models are calibrated for each water user, with water withdrawal data from 2012-2021.
- Moderate calibration is based on the median water demand for each month.
- High calibration is based on the maximum water demand for each month.
- Projections of county population and industrial sector economic growth drive long-term projections of water demand.

Table 1.1: Drivers of Water Demand

Category	Primary driver
Thermo-electric power	Electricity production
Public and domestic supply	Population
Manufacturing	Economic production
Agriculture and Golf Courses	Irrigated acres

From the projection methodology report.

Draft Water Demand Projections

- Preliminary draft results, not yet vetted.
- For demonstration purposes only.
- There will be modifications to these draft projections based on continued stakeholder feedback.
- All values are plotted as Million Gallons per Month

Thermoelectric Water Demand

Calibration
Moderate Scenario is Monthly Median
High Scenario is Monthly Maximum

Projections
According to utility company Integrated Resource Plans and feedback.

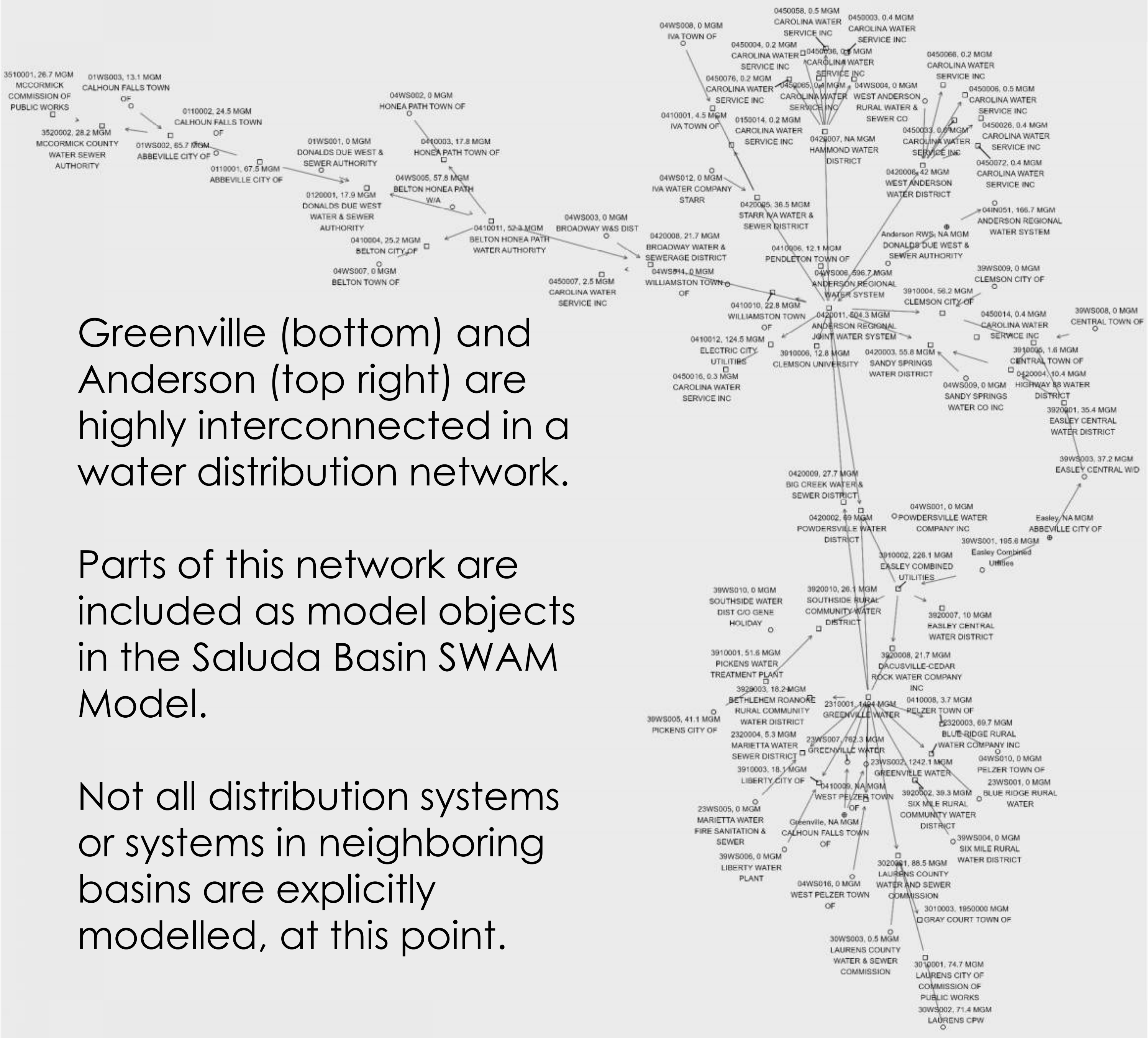
Golf, Mining, Other

Calibration
Moderate Scenario is Monthly Median
High Scenario is Monthly Maximum

Projections
No change.

Public Supply

- Many Drinking Water Distributors are interconnected by wholesale purchases and sales.
- Public Supply Systems are represented as the total of all interconnected withdrawal and distribution permits.
- Population served by each distributor is projected based on the county listed on the distribution permit.

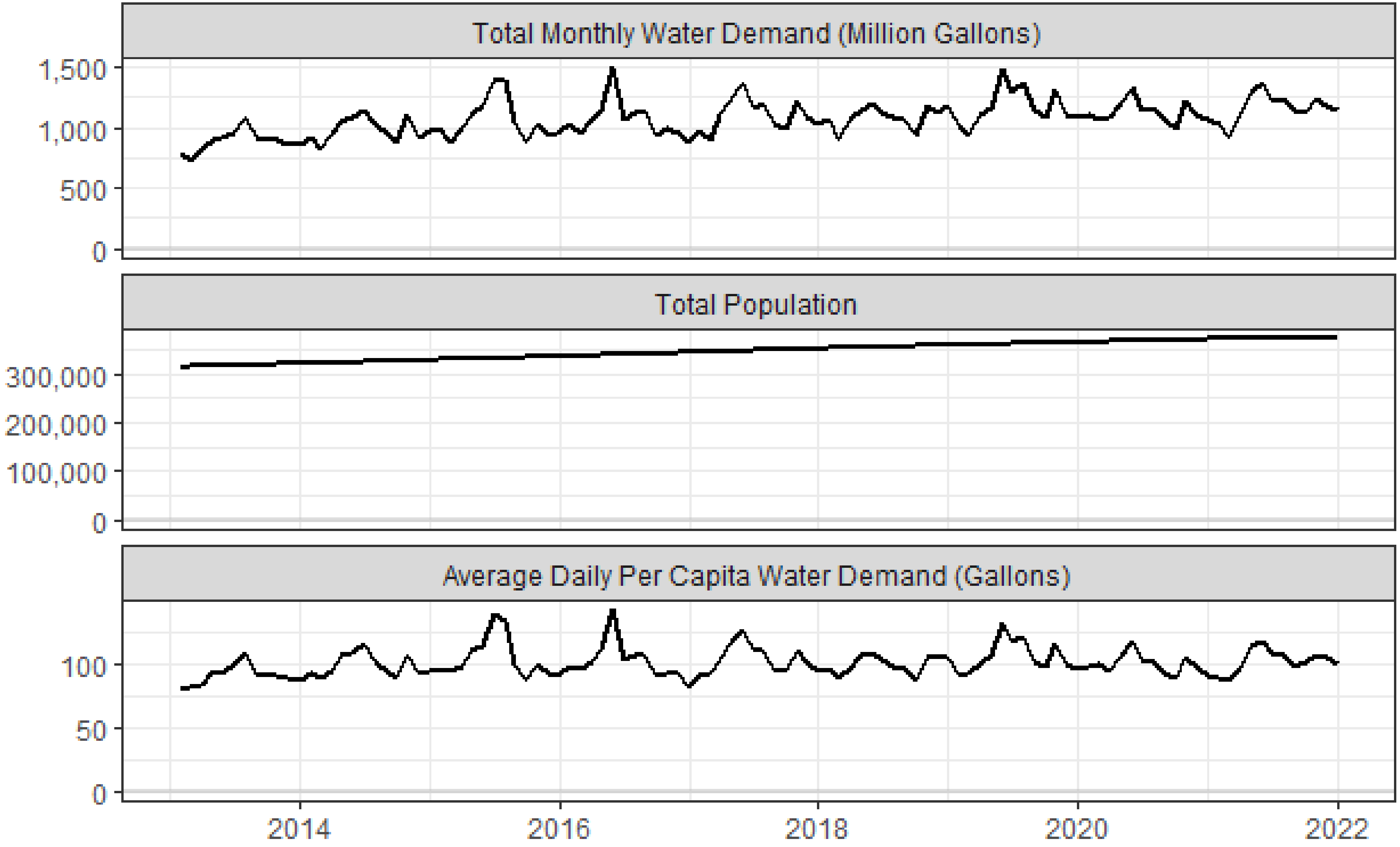


Greenville (bottom) and Anderson (top right) are highly interconnected in a water distribution network.

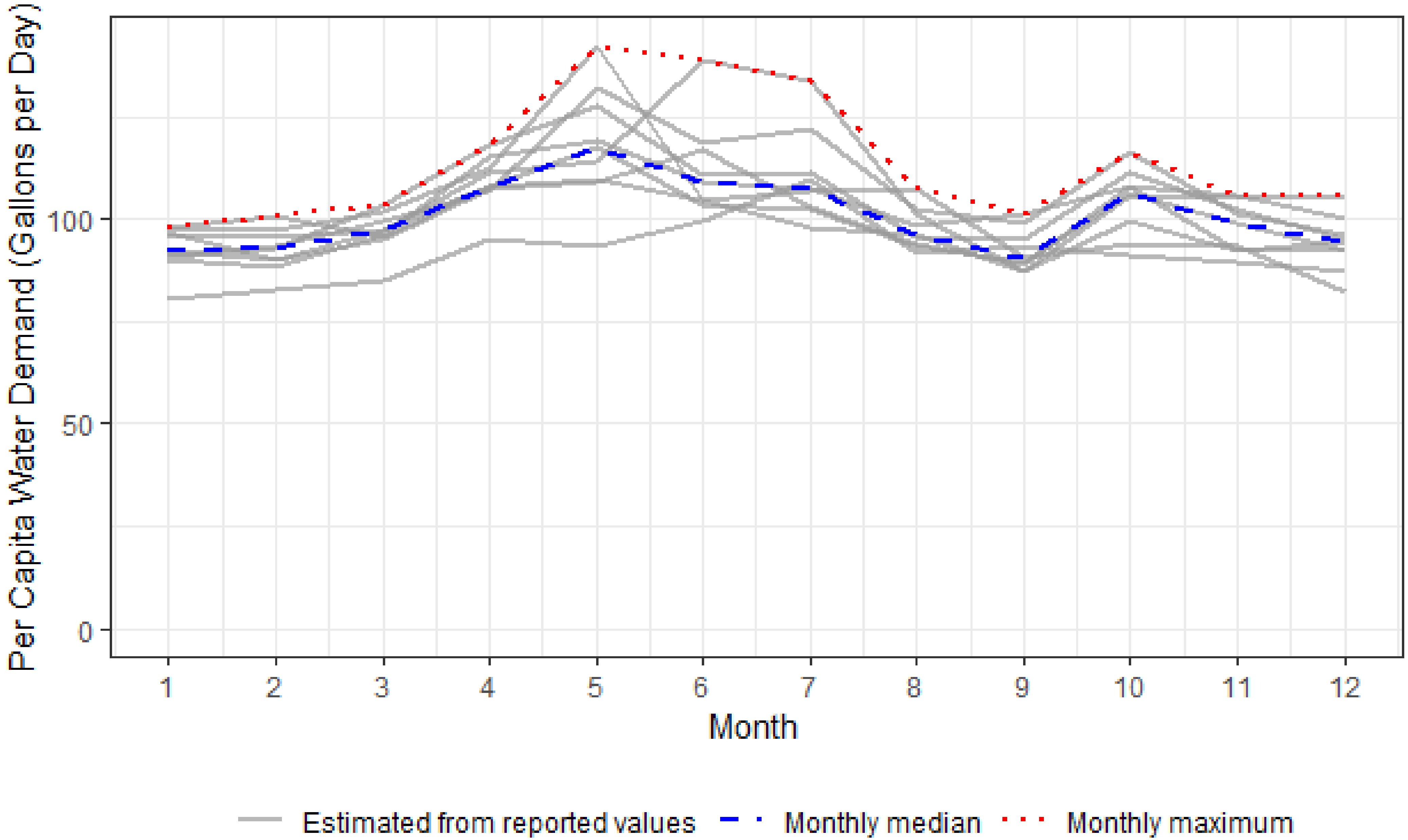
Parts of this network are included as model objects in the Saluda Basin SWAM Model.

Not all distribution systems or systems in neighboring basins are explicitly modelled, at this point.

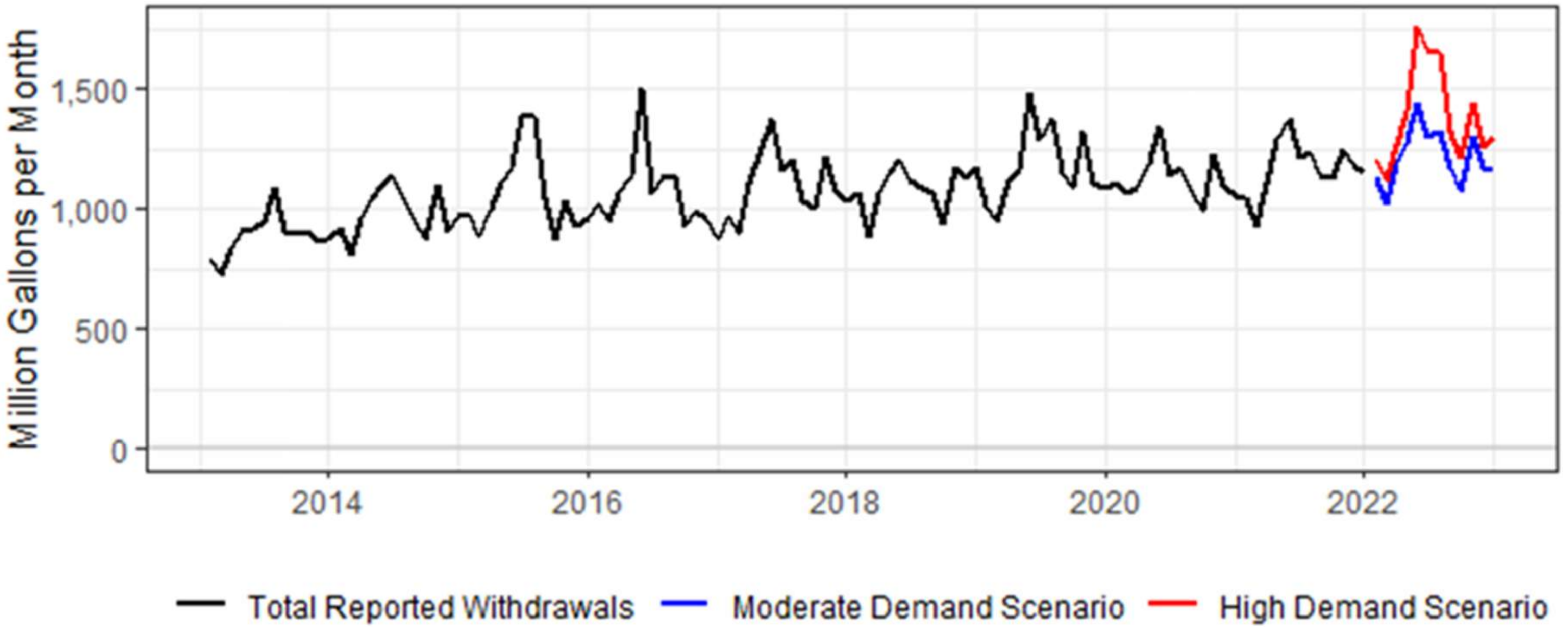
Public Supply - EXAMPLE



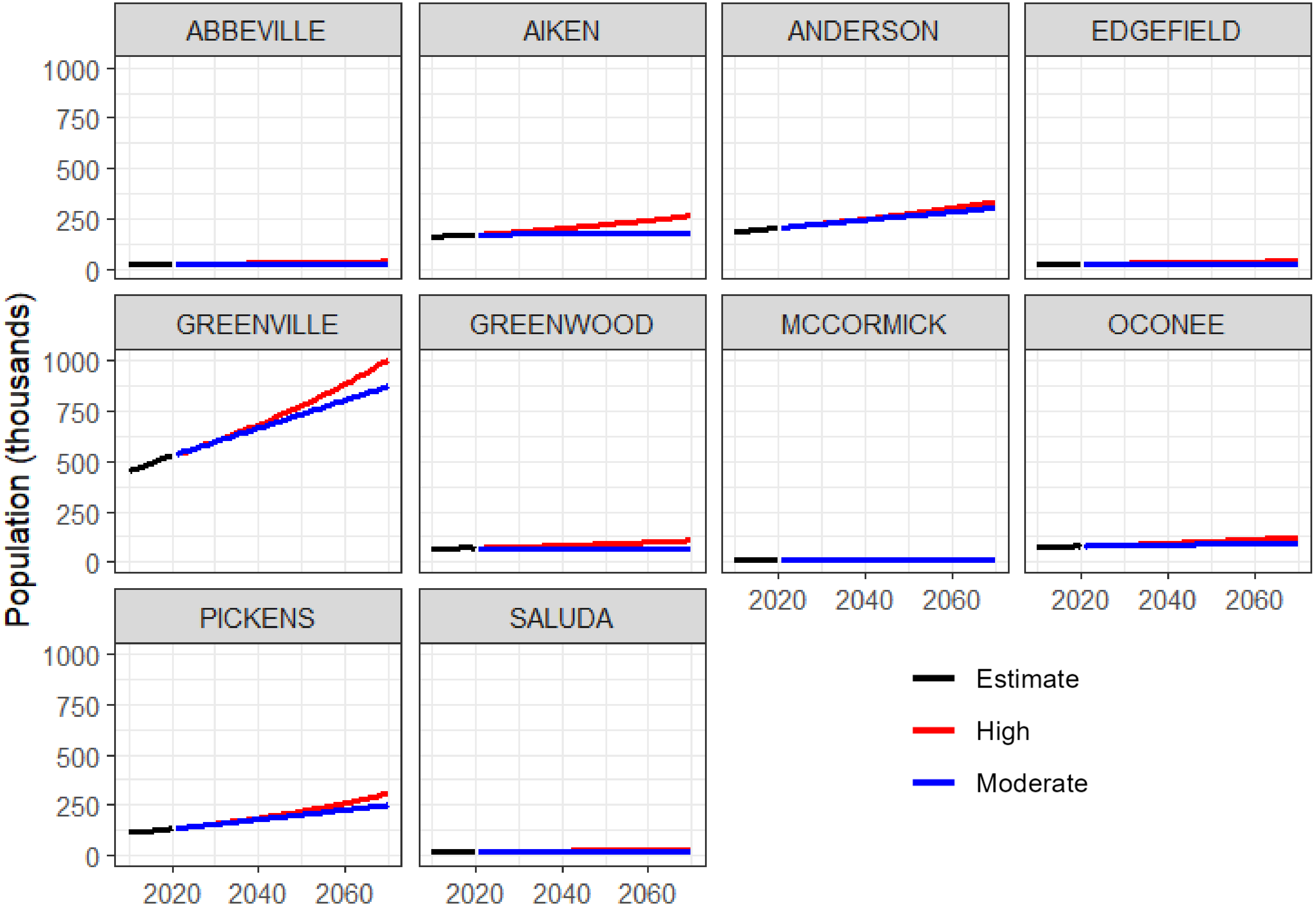
Public Supply – EXAMPLE



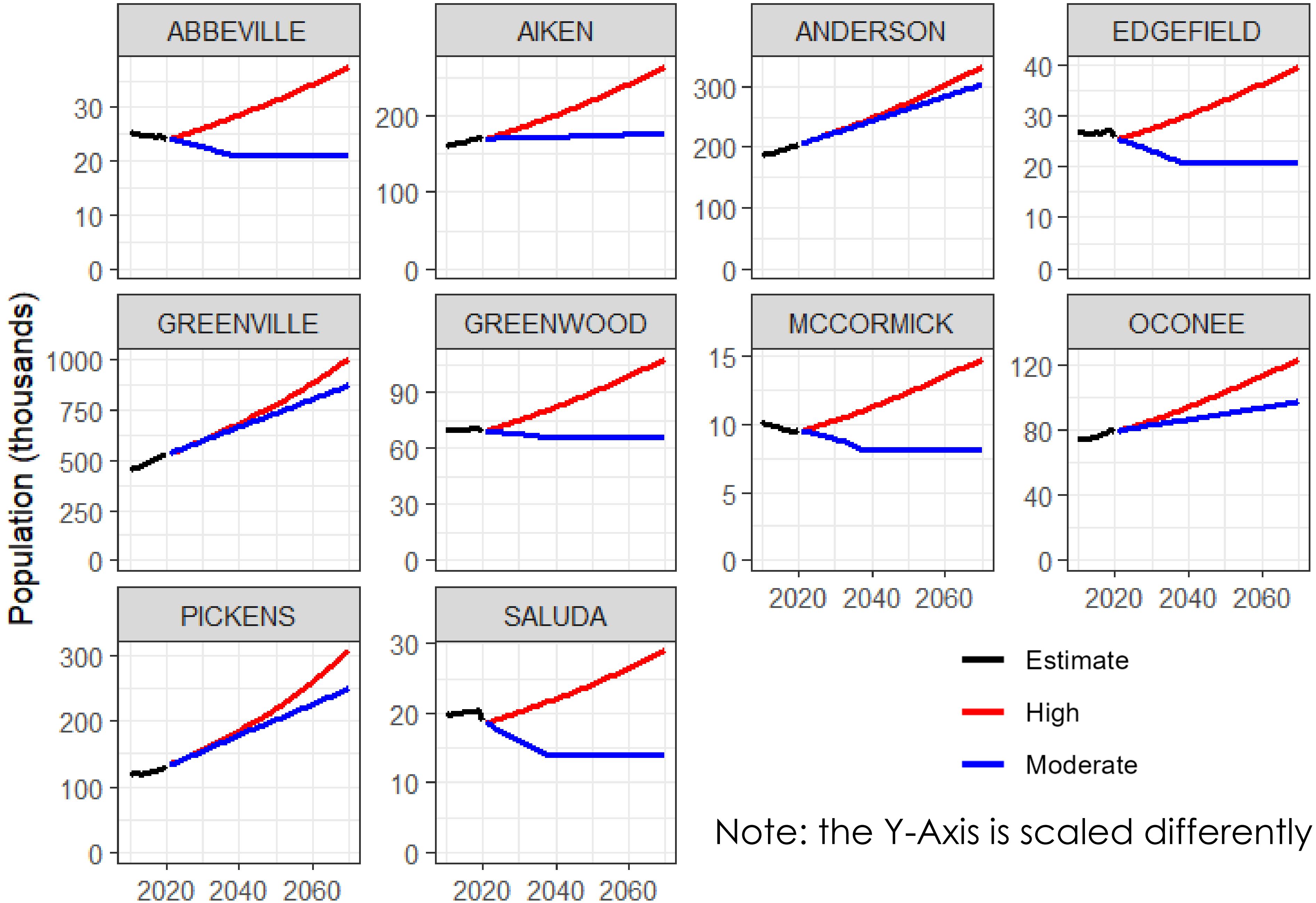
Public Supply - EXAMPLE



Population Drives Water Demand for Public Supply



Population Drives Water Demand for Public Supply



Note: the Y-Axis is scaled differently for each county.

Manufacturing

Projected Annual Economic Growth Rates from the US Energy Information Agency

Food Products	0.9%
Beverages and Tobacco Products	0.2%
Textile Mills and Products	-0.2%
Wood Products	0.0%
Furniture and Related Products	1.3%
Paper Products	0.5%
Printing	0.2%
Chemical Manufacturing	1.6%
Bulk Chemicals	1.5%
Inorganic	0.3%
Organic	1.6%
Resin, Synthetic Rubber, and Fibers	1.7%
Agricultural Chemicals	1.0%
Other Chemical Products	1.6%
Petroleum and Coal Products	0.8%
Petroleum Refineries	0.8%
Other Petroleum and Coal Products	1.1%
Plastics and Rubber Products	1.7%
Stone, Clay, and Glass Products	1.1%
Glass and Glass Products	1.0%
Cement and Lime	1.4%
Other Nonmetallic Mineral Products	1.1%
Primary Metals Industry	0.9%
Iron and Steel Mills and Products	0.1%
Alumina and Aluminum Products	1.3%
Other Primary Metal Products	1.6%
Fabricated Metal Products	1.5%
Machinery	1.8%
Computers and Electronics	2.5%
Transportation Equipment	1.7%
Electrical Equipment	2.5%
Miscellaneous Manufacturing	2.8%

Manufacturing

- Projected annual growth rates range from 0.3% to 3%, depending on the economic sector.
- Over 50 years, that leads to total increase from less than 10% to over 500%.
- In reality, water demand for manufacturing has been declining as industrial processes become more efficient and manufacturers develop higher value products.

Agricultural Irrigation

- Projected to grow from 38% (Moderate Scenario) to 44% (High Scenario) over the 50 year planning horizon
- That's about 0.7% compounded annually, comparable to recent growth rates.
- Constraints on irrigable land will be investigated.
- Projected growth will be distributed regionally, not assigned to existing withdrawal intakes.
- In the Broad Basin, we assumed no growth…

Possible Research

Industrial water purchases from public suppliers. We can expect residential and commercial use to scale per capita, not so much for industrial purchases. RBC members have indicated that growth in industrial water demand (new facilities) is expected to be met by public suppliers more than self-supply. Getting the historical record straight will improve the per-capita based modelling of residential and commercial use. Currently, new industrial water users are not considered in the water demand projections, and scenario-based modelling of new industry might be appropriate.

Public supply wholesale distribution. Anderson Regional Joint Water and Greenville Water have provided over a decade of wholesale data each. Integrating wholesale data into the water demand models will provide increased spatial resolution (each distribution system "utility" modeled separately vs interconnected networks modeled in aggregate). Filling this knowledge gap will inform questions related to source-water portfolios and consumption/return flows.

Water and sewer service areas GIS layer. This dataset is rather rough, and could use some cleaning up. Filling this knowledge gap will enable spatial analysis of public supply water use with demographic, housing, and landcover attributes.

Indoor vs outdoor and residential vs commercial use. Probably not enough data, at this point, to address this. We could try to come up with: how much data would be needed, what kind of data would be most useful, what kind of relevant data is available, what does this information contribute …

Discussion Questions

What trends are currently happening or on the horizon?

What magnitude of impact can we expect?

C. Alex Pellett
864 722 3212
PellettC@dnr.sc.gov

Manufacturers need assigned economic sectors;

distribution systems (specifically Greenville) need to be divided up in to individual SWAM model objects;

and I need to update my Saluda basin shapefile to represent the new planning basins.